

# From Pixel to Info-Cloud – News at Leica Geosystems

JACIE

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# “What else can I do with my sensor/data?”

## Earth to Image



Data Acquisition

## Image to Information

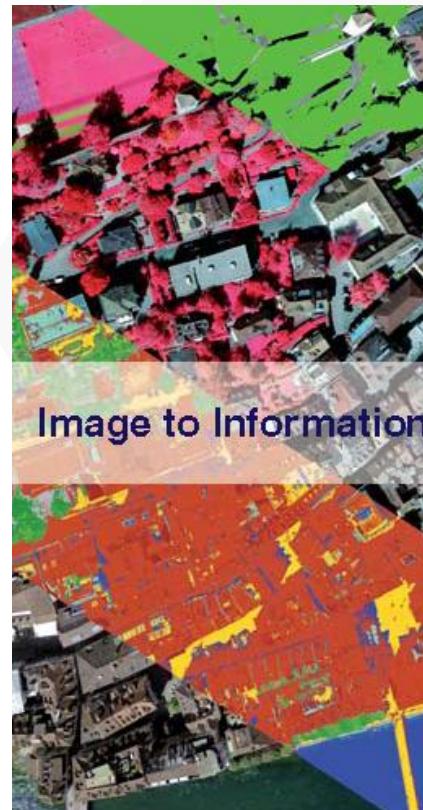
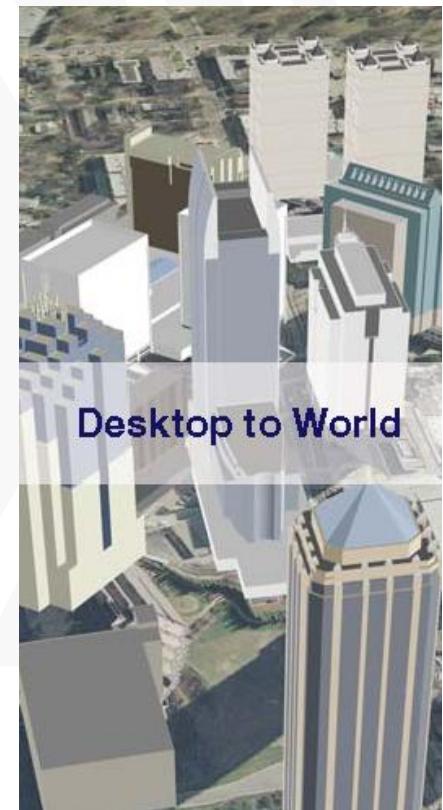
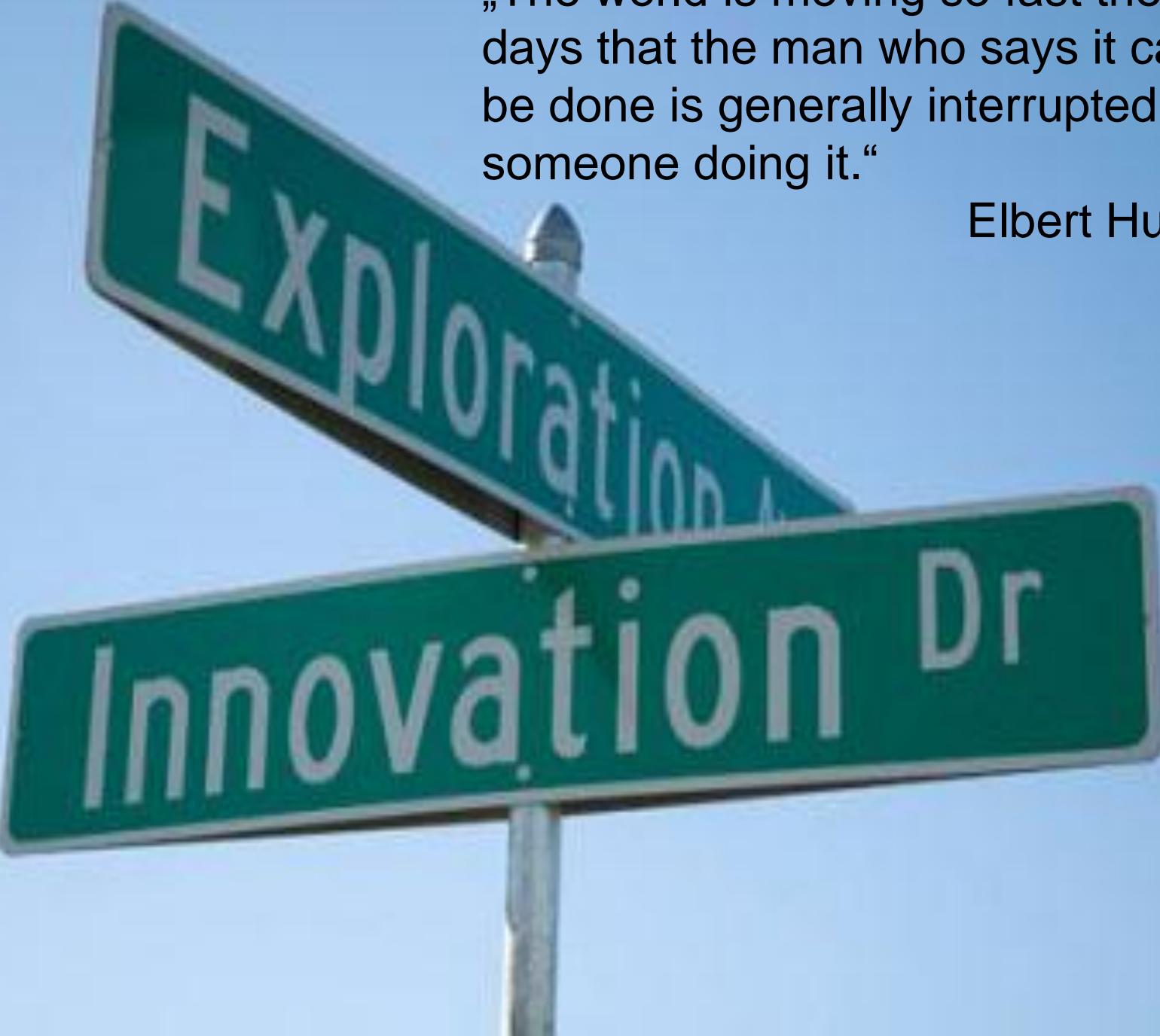


Image to Information

## Desktop to World



Desktop to World



„The world is moving so fast these days that the man who says it can't be done is generally interrupted by someone doing it.“

Elbert Hubbard

# Medium Format Frame Camera

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**Leica RCD30**

# New Leica RCD30

...because good things come in small packages!



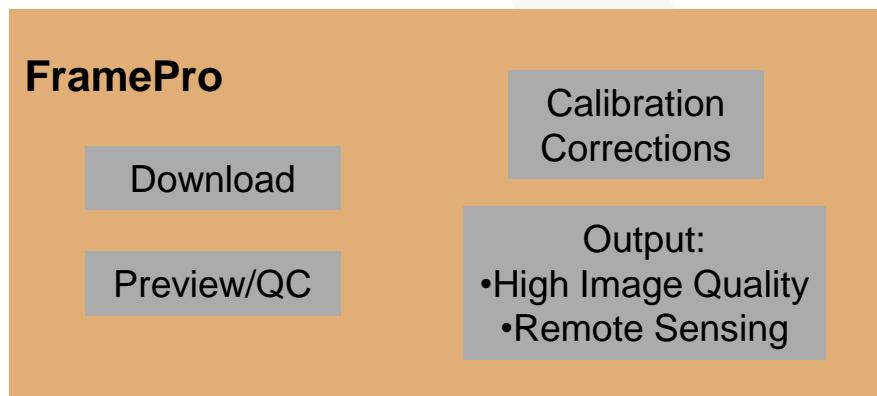
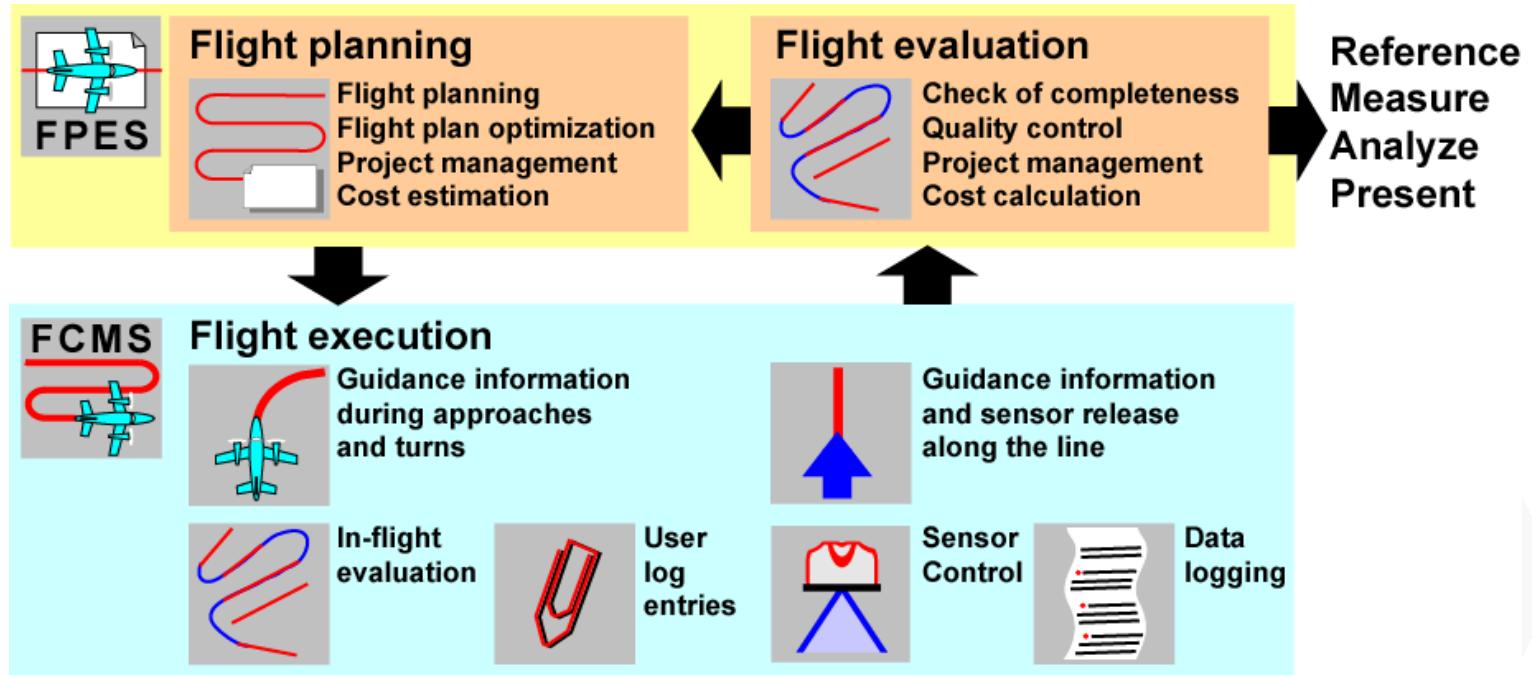
# Medium format for photogrammetry

- Multispectral, coregistered RGB and IR
- Mechanical motion compensation, 2 axes
- >1 second frame rate
- 50 mm and 80 mm focal length
- Stabilized lens system
- High accuracy mapping range
- Exchangeable central shutter
- B/H ratio of 0.32 @ 60% overlap (50mm)
- 2 x 60MP, 6um CCD for RGB and NIR
- CC3x can control up to five CH6x
- Image size single head 8956 x 6708
- Image size dual head 13216 x 8956
- 15cm GSD @ 3780ft flying height (50mm)
- Weight CH6x 4 kg, CC3x 6kg



**Swiss Technology**  
by Leica Geosystems

# Leica RCD30 - Integrated workflow



# Leica RCD30 – Fully automated goniometric lab calibration

## Two-axis horizontal goniometer with moving camera

- ◆ Theodolite-like, including measurements in two faces
- ◆ Highly precise and rigid rotation stages

## Large collimator

- ◆ ED-apo telescope lens

## Focus stage

- ◆ Large travel focus shift stage
- ◆ Rotation stage allows changing patterns
- ◆ Autocollimation camera to ensure stable infinity reference

## Patterns

- ◆ Circular pinholes of different sizes
- ◆ Horizontal and vertical bar patterns

## Illumination

- ◆ Small integrating sphere
- ◆ Filtered tungsten source and narrow band LED sources



# Leica RCD30 – Geometric calibration

Apply a square grid of points over the complete sensor

- ◆ Separate distortion measurements for each band in each grid point
- ◆ Sub-pixel accuracy by fitting ellipses to the images of the pinhole

Other use of the calibration device

- ◆ Principal point (PPA) determination
- ◆ Focus adjustment
- ◆ Sharpness measurement (MTF curves)



# Leica RCD30 - Corrections

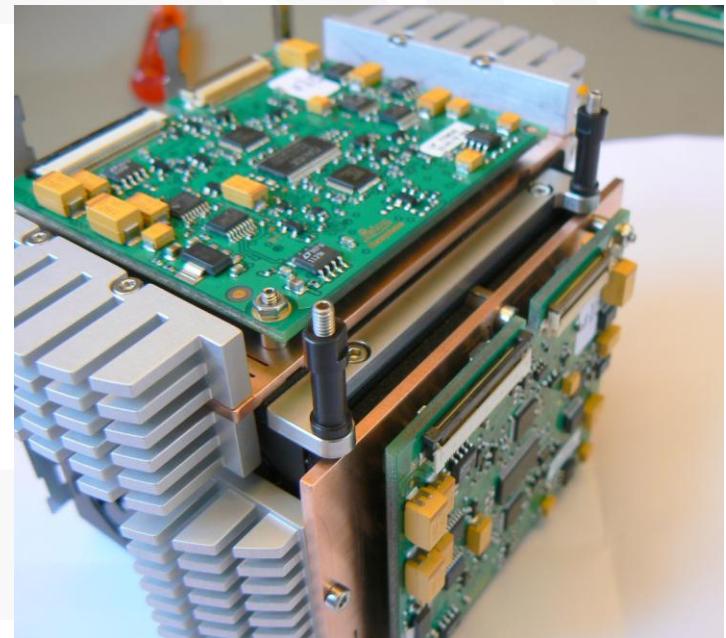
Two corrections are applied:

- ◆ Dark Signal Non-Uniformity (DSNU) for dark signal correction
- ◆ Photo Response Non Uniformity (PRNU) for bright correction separated into
  - ◆ Sensor effects (such as non uniform pixel sensitivity)
  - ◆ Lens effects (such as aperture dependant vignetting)



# Leica RCD30 - Principles of radiometric calibration

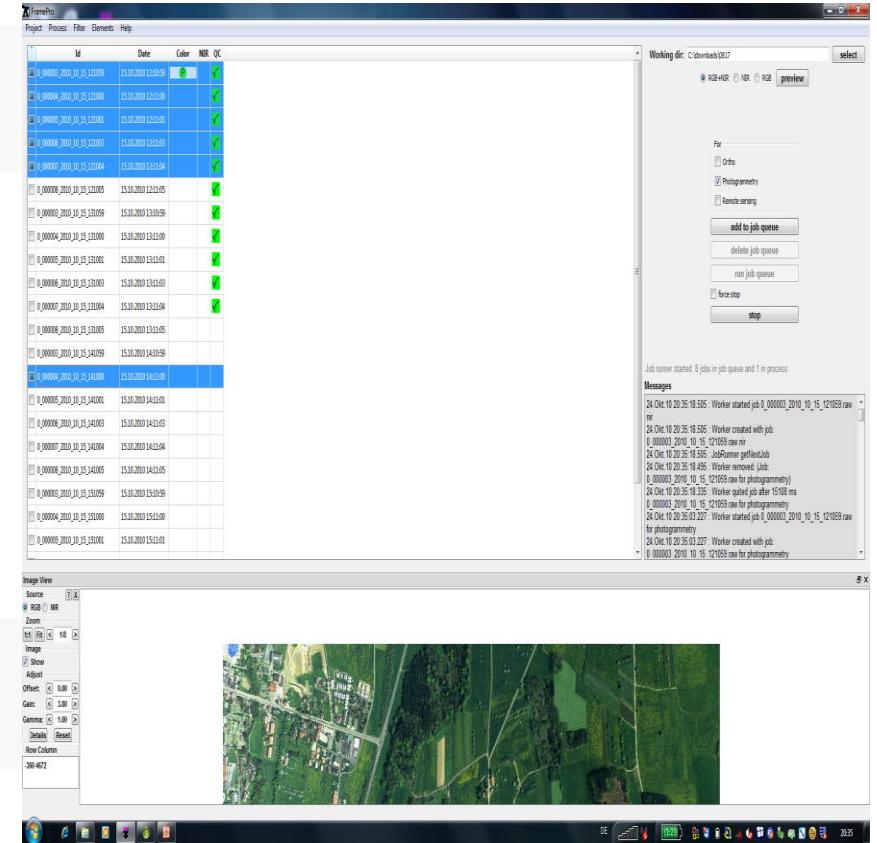
- ◆ DSNU is corrected by real data captured during flight before each flight line, so it is a dynamic correction
- ◆ PRNU, sensor part
  - ◆ For each camera, the PRNU is captured individually and stored on the camera
- ◆ PRNU, lens part
  - ◆ Lens effects are measured once for an objective and are to be assumed stable for all lenses.
  - ◆ They are only dependant from aperture



# FramePro Output – Use of the calibration grid

FramePro creates distortion-free images with a fixed principal distance:

- 16 bit four band images contain the co-registered NIR and RGB bands
- RGB, false colour and 8 bit are of course also possible
- Corrections for chromatic aberration and FMC position are applied



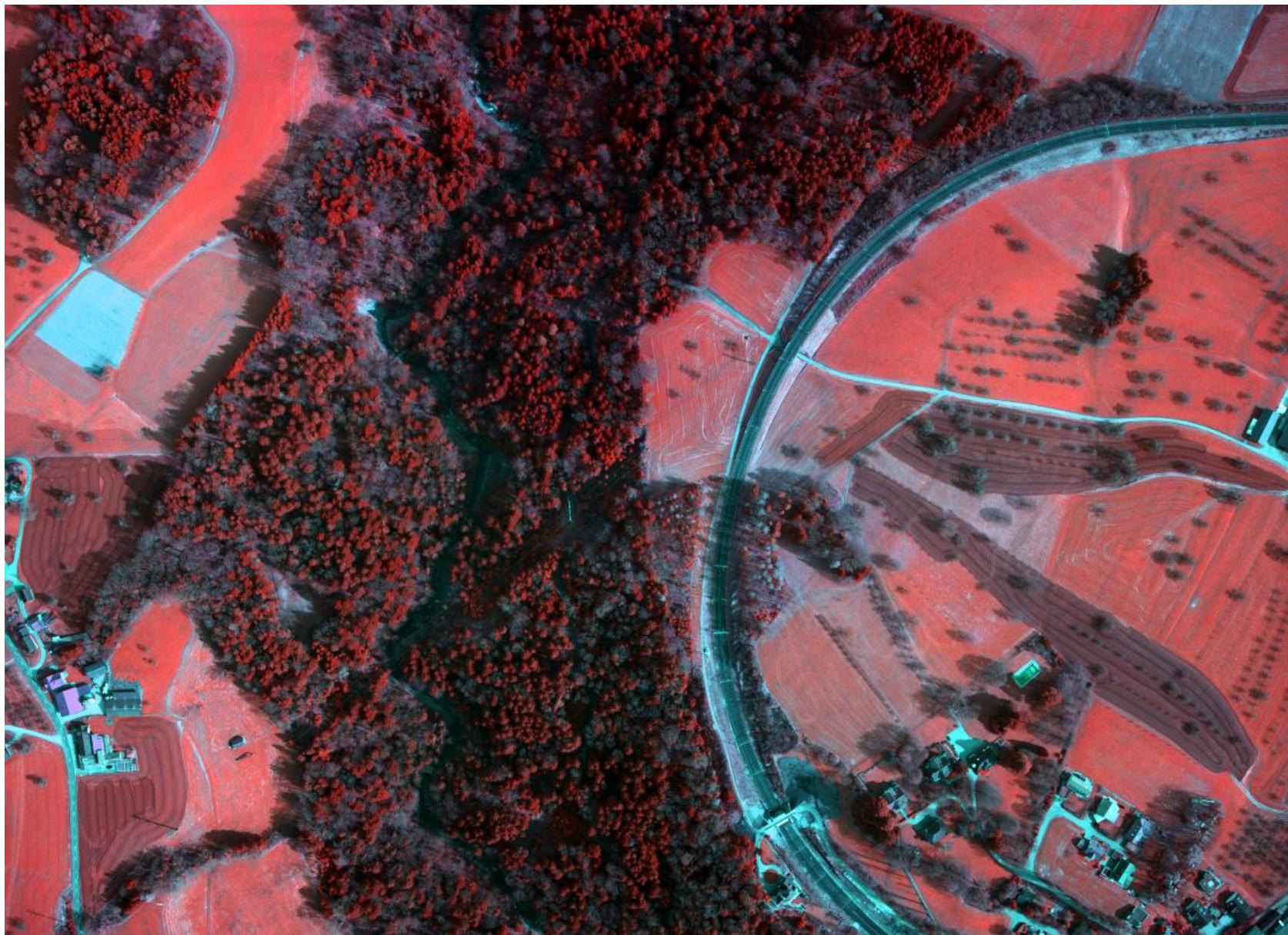
## Advantage:

Images can be imported into any downstream application without caring about the distortion model

# Images – RGB, 1650 AGL, 80mm, 20ms



# Images - FCIR



# Images - RGB

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# Images - RGB

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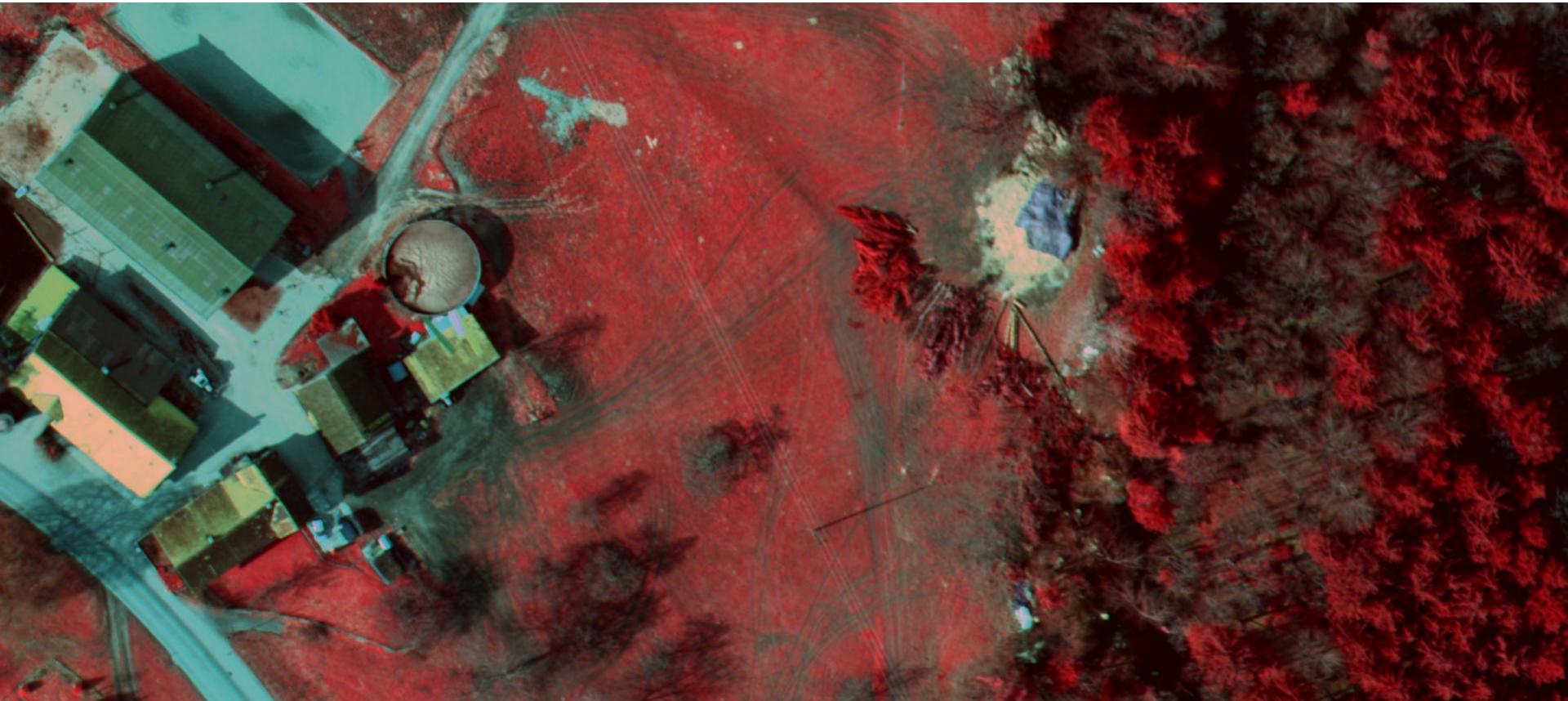
# Images - FCIR

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# Images - RGB

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# “What else can I do with my sensor/data?”

## Earth to Image



Data Acquisition



## Image to Information



Image to Information



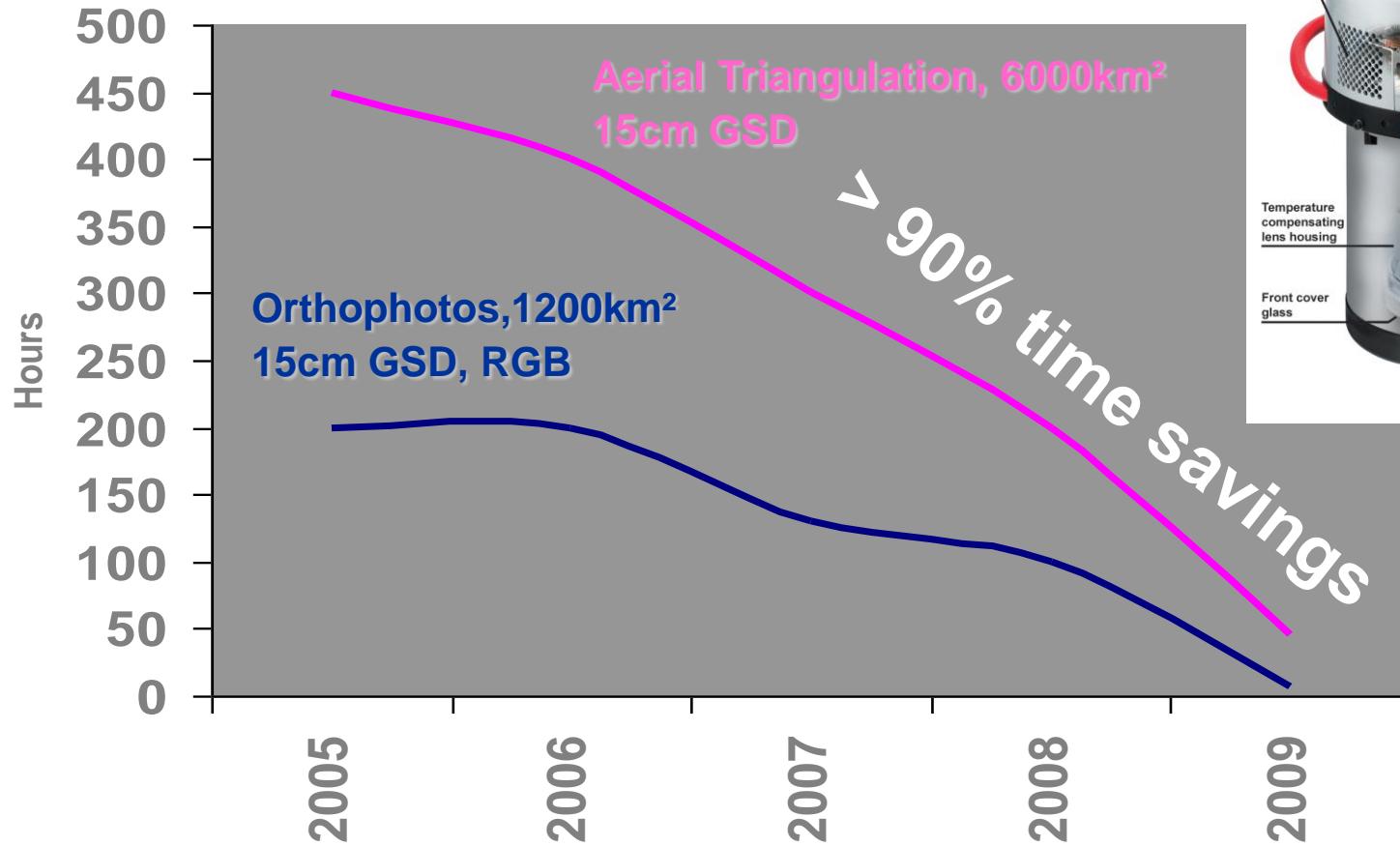
## Desktop to World



Desktop to World



# Office Productivity - Airborne Imaging



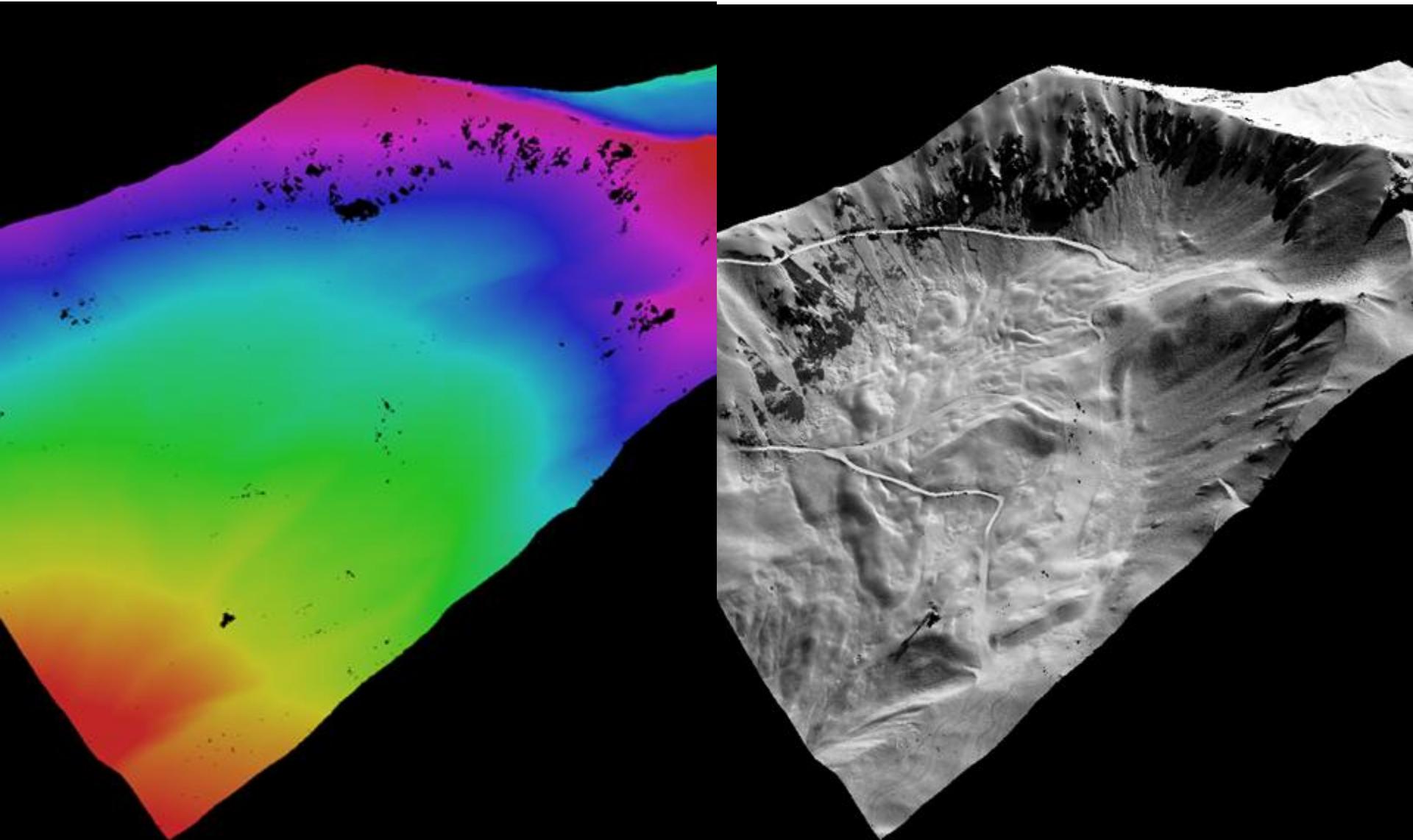
# Driving Productivity in Imaging

## Extremely Fast Data Processing

		Flight	1,200 km <sup>2</sup> , 15cm GSD 12 lines, each 80 km, 3 Pan and 8 MS Approximately 7 hr flight at 130 knots	Total time WS with 6 server cluster	User action time
	Download		400 GB ADS data format	4 h	0.5 h
	Geo-referencing		Trajectory calculation geo-referencing of L0 images	0.5 h 0.1 h	0.5 h 0.1 h
	Aerial triangulation		Automatic Point Measurement Bundle Adjustment	0.1 h 0.3 h	0.1 h 0.3 h
	Ortho photo		RGB or FCIR 1,200 km <sup>2</sup>	1.7 h	0.1 h
	Feature extraction		Due to image strips slightly faster than in traditional workflow	6.7 h	1.6 h
	Fly-through		Similar to traditional workflow		

# New Leica XPro 5.0 DSM

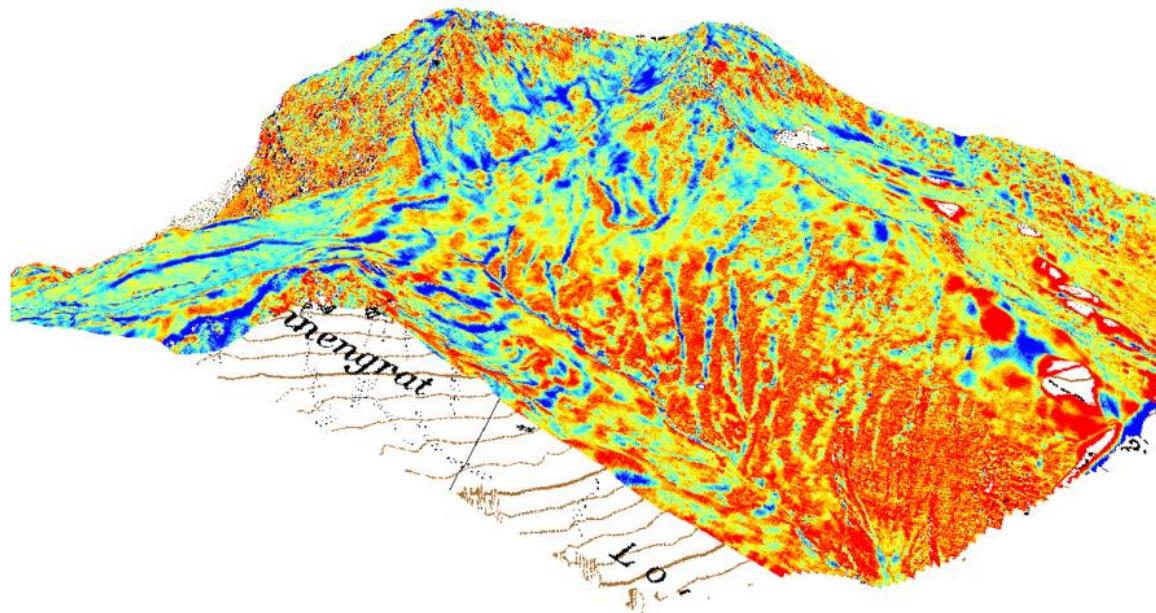
Large Area DSM Extraction from ADS Imagery – based on SGM  
pixel matching



# Case Study - Snowdepth



Continuous, high resolution snow depth mapping  
using remote sensing techniques



Yves Bühler<sup>1</sup>, Luca Egli<sup>1</sup>, Mauro Marty<sup>2</sup> and Christian Ginzler<sup>2</sup>



<sup>1</sup> WSL Institute for Snow and Avalanche Research SLF



<sup>2</sup> Swiss Federal Institute for Forest, Snow and Landscape Research WSL

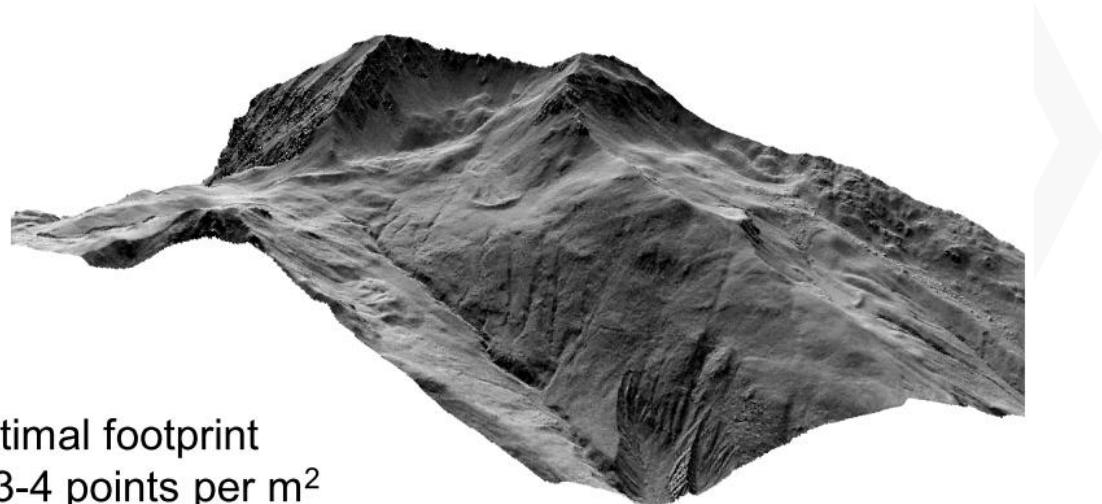
# Case Study - Snowdepth



- Airborne Laser Scanning ALS



Summer 2009



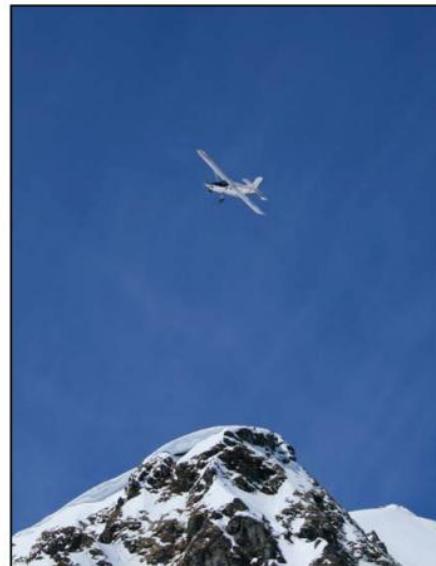
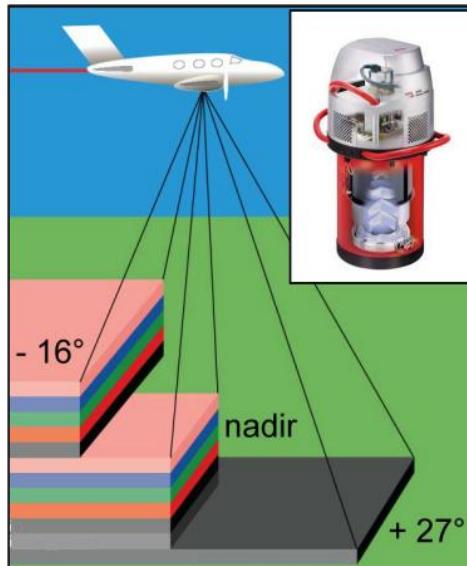
- Helimap System
- Rotatable LiDAR -> optimal footprint
- Spatial resolution: ca. 3-4 points per m<sup>2</sup>
- Estimated z-accuracy ca. 0.1m

(Vallet et al. 2005, Skaloud et al. 2006)

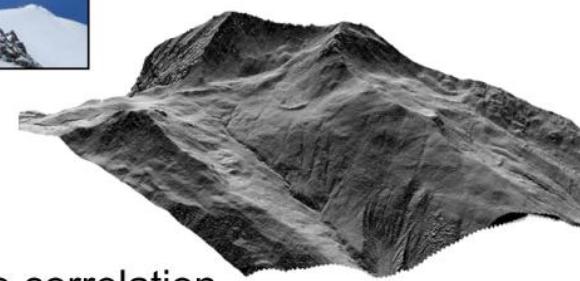
# Case Study - Snowdepth



- Airborne opto-electronic scanner ADS80



pan:	465 – 680 nm
blue:	430 – 490 nm
green:	535 – 585 nm
red:	610 – 660 nm
nir:	835 – 885 nm



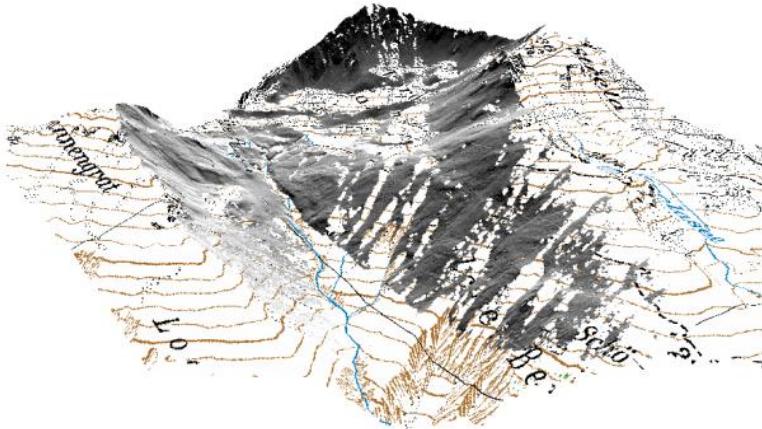
- Summer and winter DSM
- Spatial resolution: 5 bis 50 cm
- Radiometric resolution: 12bit
- DSM generation by photogrammetric image correlation

(Leica 2010)

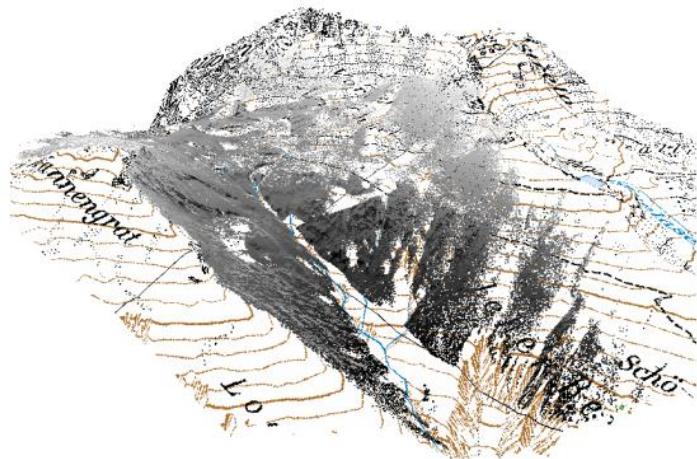
# Case Study - Snowdepth



- Terrestrial Laser Scanning TLS



summer: August 8<sup>th</sup> 2008 & July 13<sup>th</sup> 2010



winter: April 16<sup>th</sup> 2010 = peak of winter

- Riegel LPM 321
- Wavelength: 905 nm
- Spatial resolution: 0.05°
- Estimated close range z-accuracy ca. 0.1m

(Riegel 2008, Prokop et al. 2008)



# Case Study - Snowdepth



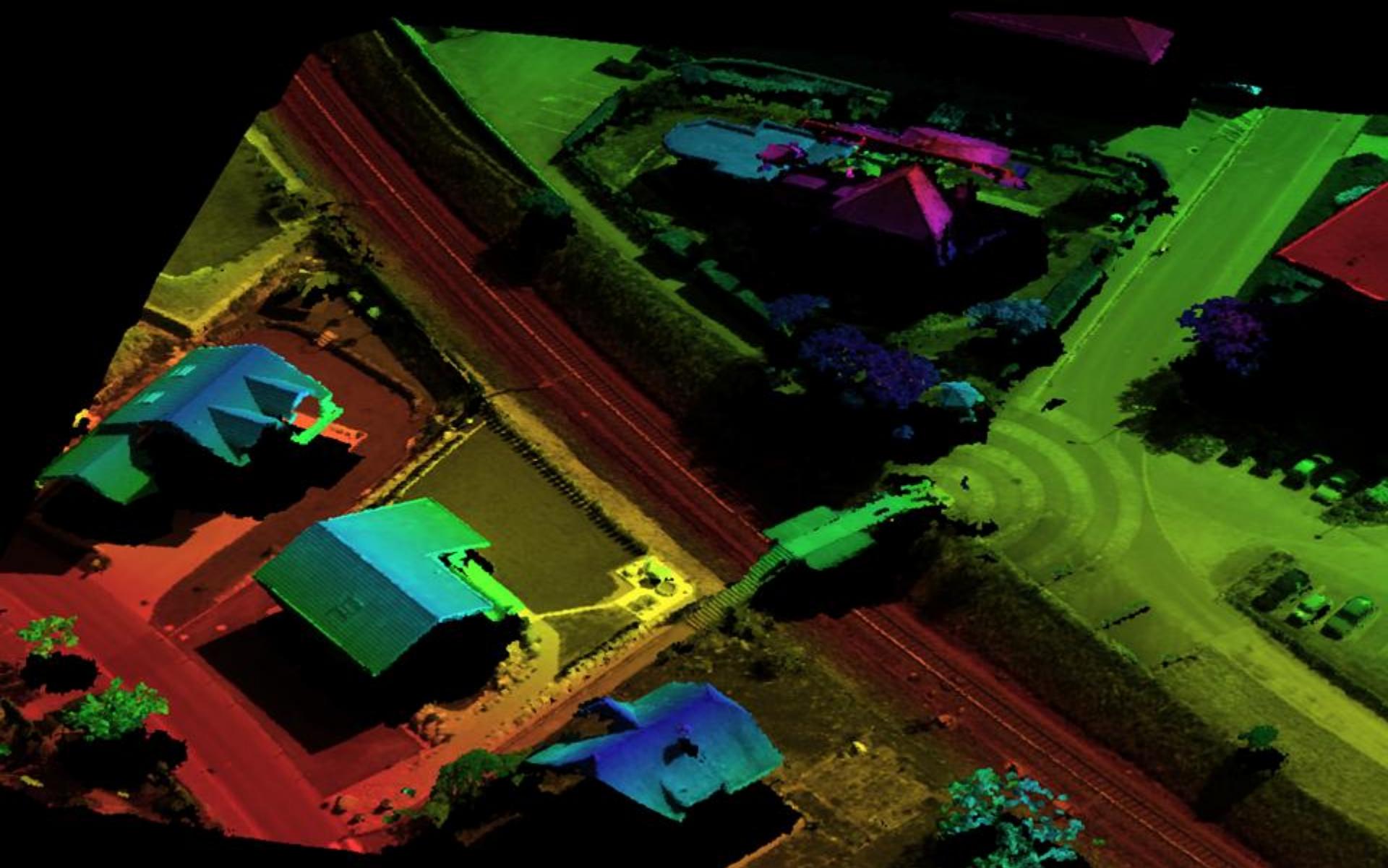
## Conclusions

- **Continuous** and **wide area** coverage with ADS80, **cost effective**
- ADS80 snow depth map is **qualitatively comparable** to laser scanning
- Potential for **improvement**: snow cover maps to identify snow free area  
→ ADS imagery, matching quality flags (eliminates most outliers)
- **Spatial structure** of snow depth distribution captured
- Individual measurement points can strongly deviate due to different **error sources** (steep slope, x,y shift, image correlation, scan position)

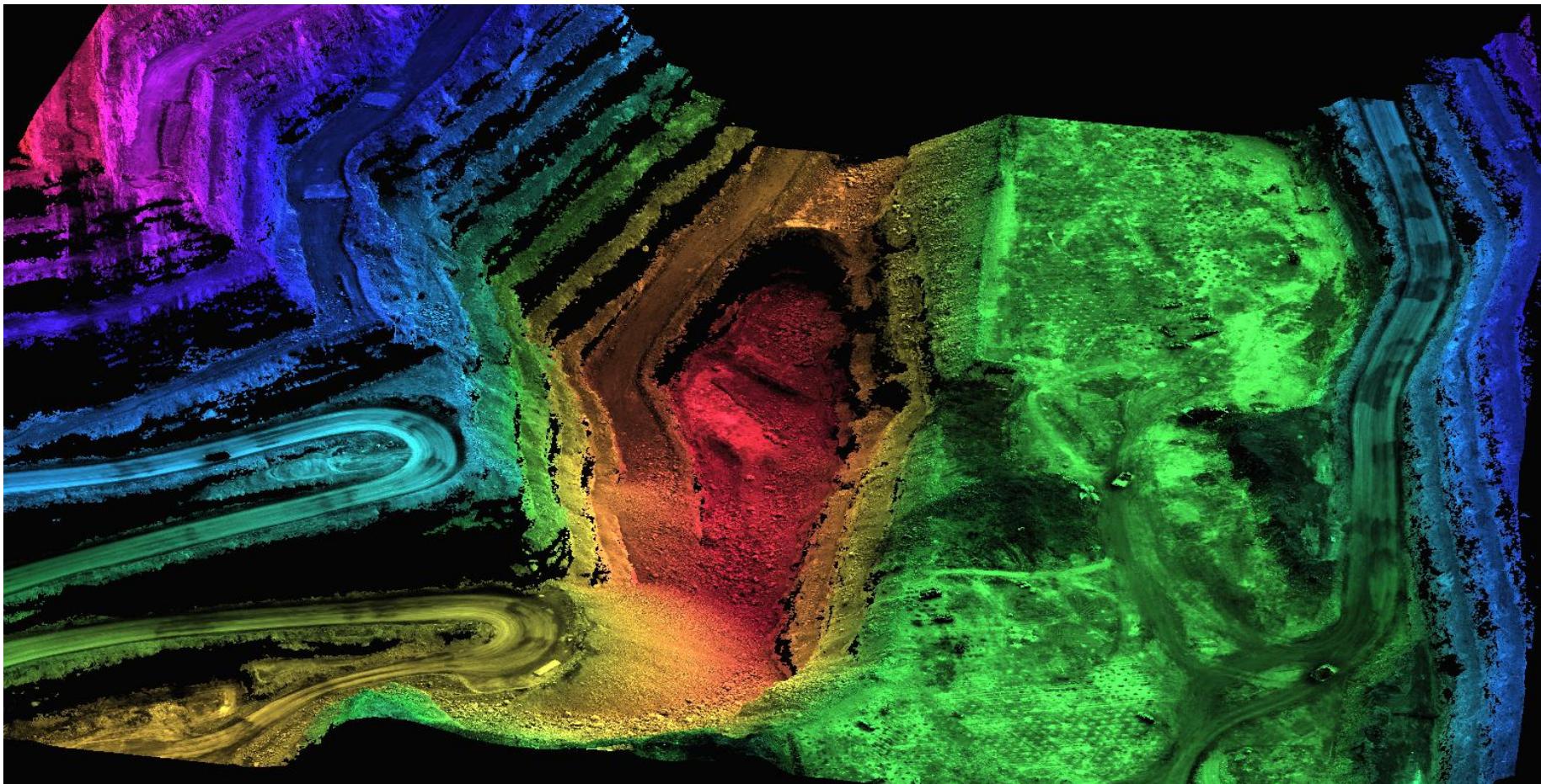


# New Leica XPro 5.0 DSM

## Large Scale DSM Extraction from ADS Imagery

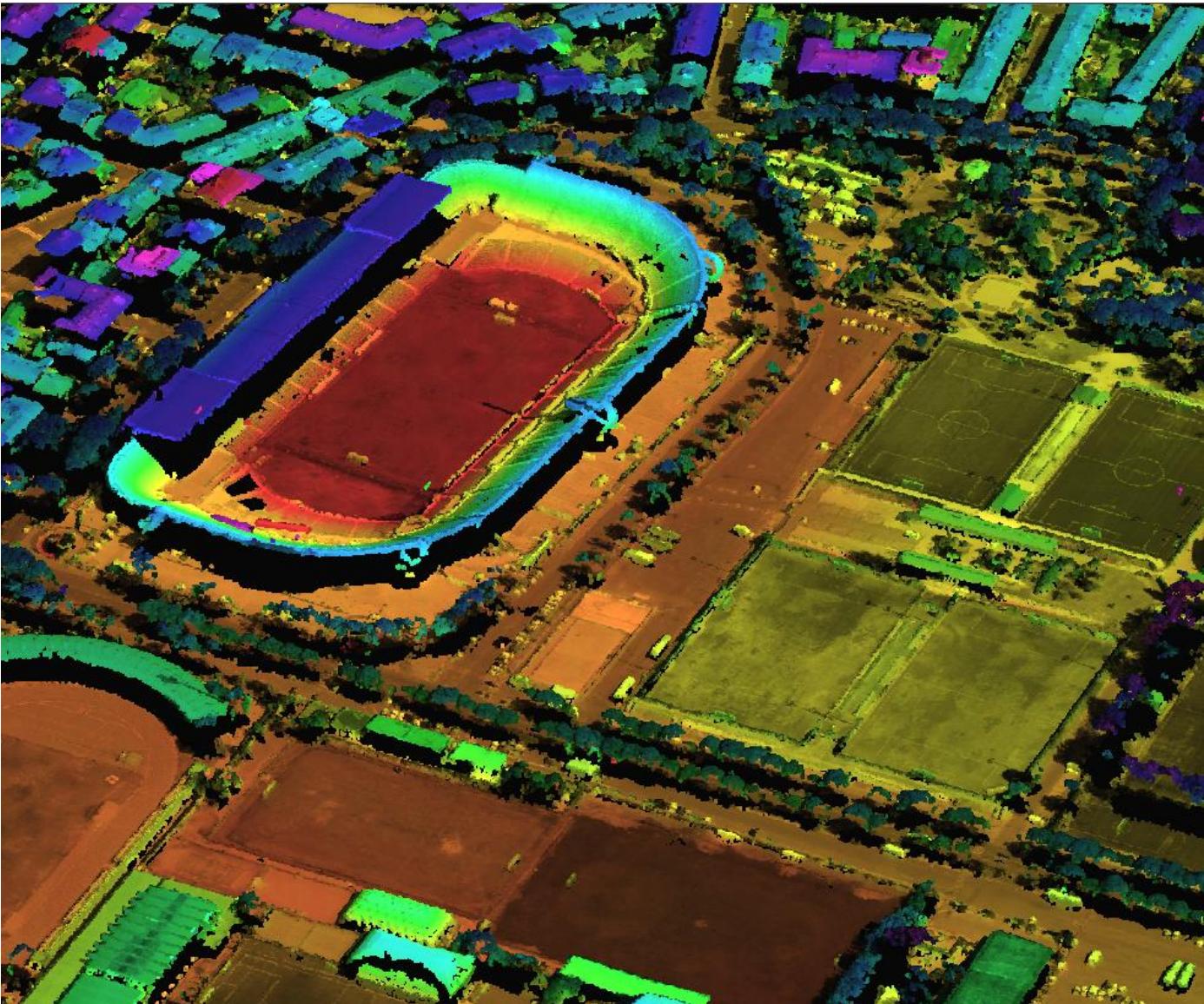


# Leica XPro DSM - Mining



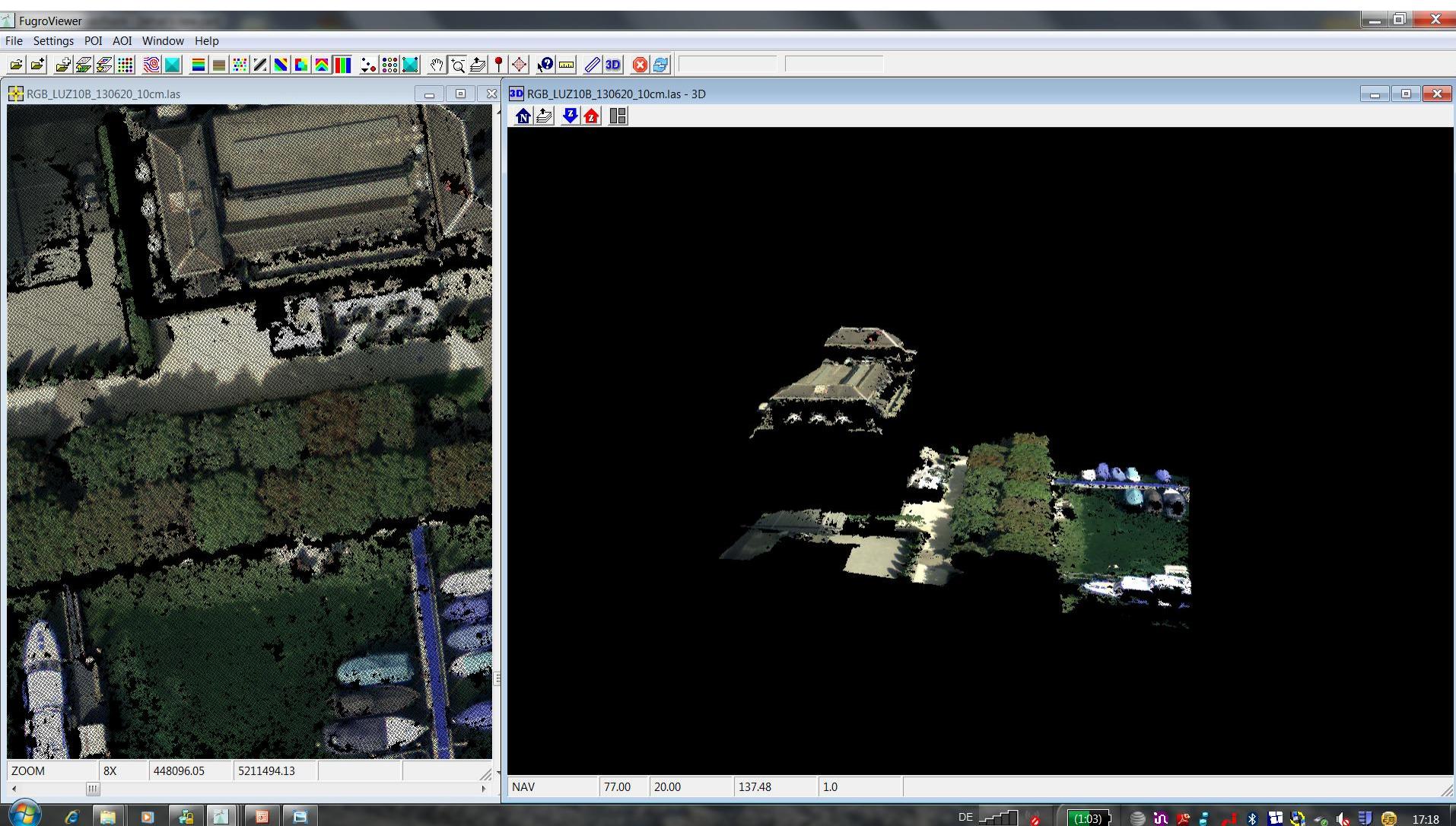
Data courtesy of Fugro Spatial Solutions, Australia

# Leica XPro DSM – 3D City Modelling

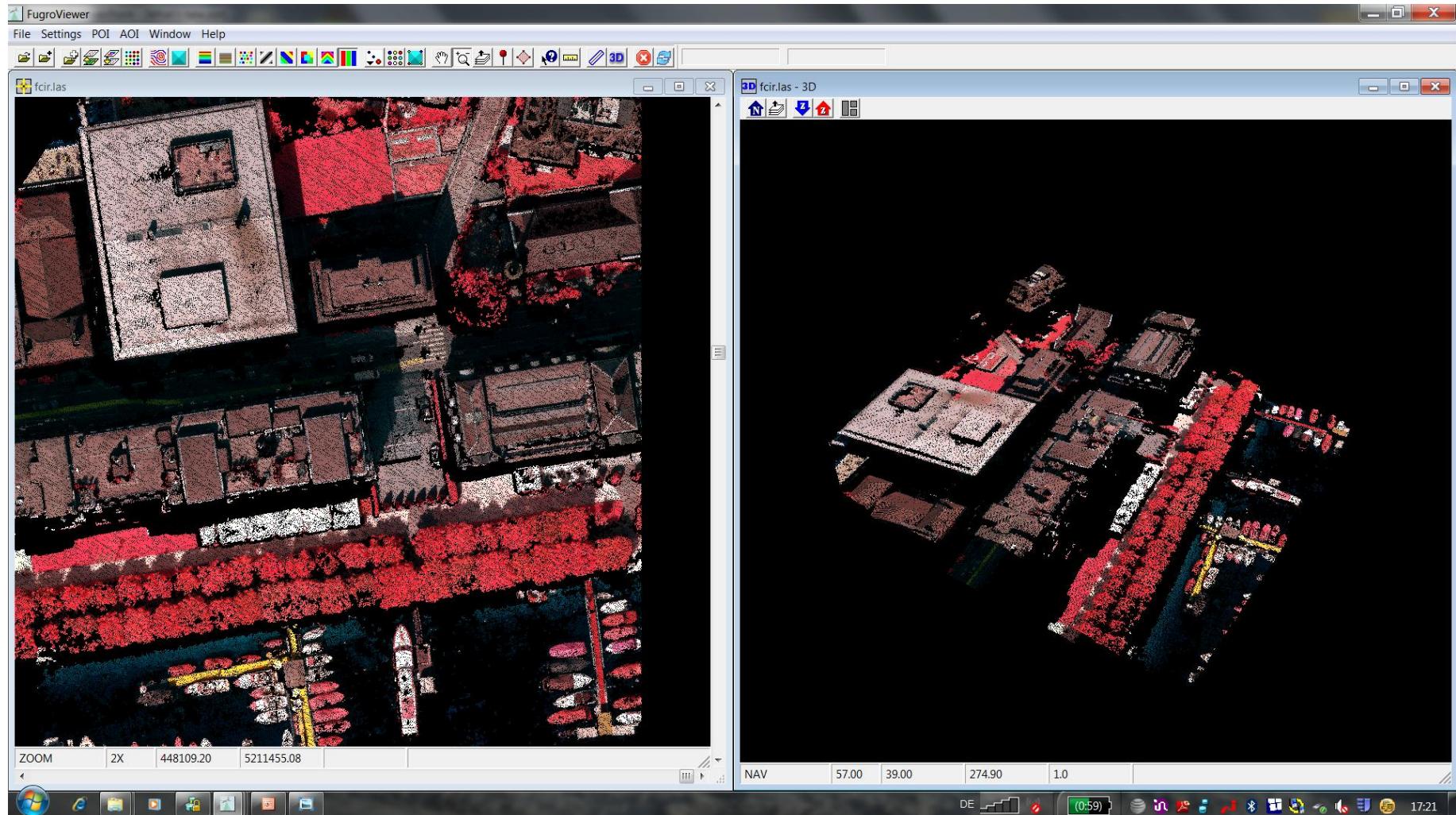


Data courtesy of Blom CGR S.p.A, Italy

# Leica XPro DSM – 3D City Modelling



# Leica XPro DSM – Environmental City Modelling





# Thank you!